Glacial Deposits of

South-Central Fayette County, Ohio

A Senior Thesis

Presented in Partial Fulfillment of the Requirements for

the Degree Bachelor of Science

by

Harold Everett Johnson II

The Ohio State University

2005

Lawrence Krissek

Advisor

Geological Sciences

Abstract

Glacial deposits are common and varied across Ohio. These deposits chiefly include lodgment till, ablation till, and outwash. All of these sediment types can be found by drilling into the subsurface of Fayette County, Ohio. The study region, located in the south-central portion of Fayette County (along Miami Trace Road), was examined for glacial deposits using data collected from water well logs and drilling reports. Additional data sources including topographic maps, open-file bedrock geology maps, and open-file bedrock topography maps were used and a cross-section constructed. Variations in bedrock topography record effects of the Teays Stage drainage and the Deep Stage drainage, which in turn influences the thickness of drift. The overlying glacial sediments consistently show an upward pattern of hardpan, sand, and oxidized clay loam in both the ground moraine and end moraine landforms. This sequence is interpreted to record a glacial advance, an increase in meltwater, and the deposition of the uppermost layer either from supraglacial/englacial debris or by a second advance of the Wisconsinan ice sheet.

Table of Contents

Acknowledgements

I would like express my sincere gratitude to Professor Lawrence Krissek for his constructive comments, editing, and review of this senior thesis throughout its duration. His "red ink" is most valuable to me as I continue to develop my skills in scientific writing. I am grateful for the previous work of the Ohio Department of Natural Resources and for archived well logs and drilling reports used in my study. In addition, I would like to show appreciation and recognize the cable tool well drilling firms for their efforts in recording the glacial deposits; without these records this paper would not have been possible. Since I grew up in the well drilling industry, I would like to specially acknowledge to the following, who I have known or been told about and whose work toward recording local geology is highly respected: J.T. Barker of Barker Well Drilling, Robert Conner of Conner Well Drilling, Rearick Well Drilling, Glen McCoy of McCoy Well Drilling, Rodney and Don Trefz of Trefz Well Drilling, Elmer C. Chenoweth of Chenoweth Well Drilling, Forrest Skinner of Skinner Brothers Well Drilling, Harry Short (great-grandfather), John W. Short (grandfather), and Bill Holloway of Staunton/Shorts Well Drilling, Harold E. Johnson Sr.(father) of H.E. Johnson Well Drilling, and Bob Bennett. Lastly, I want to dedicate my thesis in remembrance of my dearest friend and uncle, Herman Johnson, who unexpectedly passed away earlier this year and will be greatly missed.

Background

Nearly two-thirds of present-day Ohio contains evidence of having been glaciated by one or more major glacial advances during the Pleistocene (Hansen 1997). The effects of these continental ice sheets can be investigated using sediments deposited by the glaciers and their meltwater. The glacial episodes recorded by these sediments include the Pre-Illinoian (older than 300,000 years B.P.), the Illinoian (~130,000 to ~300,000 years B.P.), and the Wisconsinan (~14,000 to ~24,000 years B.P.) (Pavey et al. 1999).

These glacial sediments overlie bedrock topography that preserves former drainage channels that have been classified into the Teays Stage or Deep Stage. Known as the Teays Stage because of the Teays River, this Pre-Illinoian drainage crossed Ohio from south-southeast to the northwest (Hansen 2003). The effects of the earliest glacial advance (Pre-Illinoian) began as the Teays River was blocked by the advancing ice sheet (Teller 1964). Following the "damming" of the Teays River, large bodies of meltwater collected in the lowlands. Soon the meltwater crested the Appalachian highlands, creating a southern drainage route (Rosengreen 1971). This southerly Pre-Illinoian Deep Stage drainage system is interpreted as having been formed rapidly, and eroded narrow, deep drainage channels into the bedrock (Angle 2004).

The penultimate glaciation also modified the drainage by helping to destroy and renew parts of both the Teays Stage and the Deep Stage channels. The contributions of this glacial advance include damming up existing streams, burying existing streams with a thick layer of drift, and establishing new channels not related to the previous stages. This Illinoian drainage pattern is complex and difficult to interpret, as the channels are only recorded in the sediments deposited by meltwater that drained down gradient (Stout et al 1943).

The most recent glaciation, the Wisconsinan, was responsible for much of the current drainage patterns in the glaciated parts of Ohio. Flow tends to be from the higher end moraines, kames, and eskers to the lower ground moraine. In some cases, stream valleys were widened significantly by large amounts of glacial meltwater, so that modern small streams sit in oversized valleys (Stout et al. 1943). In addition to the modification of drainage, it is likely that older sediments were reworked by ice and meltwater except in a few localized places where a paleosol is present between the older and younger tills (Teller 1964).

During the retreat of the Wisconsinan ice sheet, Ohio's current topography of hills and plains was created, which are interpreted as end moraines and ground moraines, respectively (Pavey et al. 1999). The end moraines, or "hills", are composed of ablation or "meltwater" till, deposited during an episode of ice terminus stability where melting resulted in a traceable, less compacted deposit along the distal edge of the ice sheet (Angle 2004). Ground moraine is also composed of till; however, it was deposited at the base of an advancing glacier so it is more densely compacted. This ground moraine is commonly referred to as being "plastered-down" or "bulldozed" (Angle 2004). Both till types are very similar in composition, with both types being made of an unsorted, non-stratified combination of gravel, sand, silt, and clay (Benn and Evans 1998). These sediments commonly are composed of pieces eroded from the bedrock that the glacier was sliding on. This erosion created angular rock fragments as well as "glacial flour" (Plummer et al 2003). When such till is "unoxidized", or not altered from its initial composition by weathering of the till, many well drillers refer to it as "hardpan". Once the till is oxidized, it is recorded on the well log and drilling report as "clay", even though it is actually more of a clay loam. In Fayette County, the majority of the parent rock was carbonate (limestones/dolomites), with a lesser amount of shale (Stout et al. 1943). However, some igneous/metamorphic clasts are present, derived from the Pre-Cambrian Shield in Ontario because the glaciers originated generally to Ohio's north (Benn and Evans 1998).

Another widespread material deposited in association with these large ice sheets is collectively referred to as sand and gravel. Like till, the source for this material can be local sedimentary rocks or more distant igneous/metamorphic rocks (Plummer et al. 2003). The sand and gravel occur either as ice contact deposits (kames and eskers) or as outwash deposited by glacifluvial meltwater. Although ice contact and outwash deposits are formed from the same type of material, differences in the shape of the deposit, and the presence or absence of grading, sorting, and/or crossbedding can be used to interpret the environment of deposition (Benn and Evans 1998).

A kame is a supraglacial or "glacier surface" ice-contact landform, deposited from a stranded ice block with a depression on its surface that is filled with sand and gravel. After the ice block melts completely away, a mound of sand and gravel remains, commonly lacking grading, sorting, and crossbedding. The other ice-contact deposit, an esker, is a "snake-like" deposit of sand and gravel formed subglacially in an ice-confined drainage tunnel. Typically, an esker will exhibit some indications of grading and crossbedding, even if those characteristics are poorly developed (Stout et al. 1943).

The last type of sand and gravel deposit is a glacifluvial deposit. These deposits can be found in both glaciated and unglaciated parts of Ohio, as the meltwater streams had sufficient energy to carry sediments far away from the glacier front. Generally, the majority of the outwash found today in unglaciated southeastern Ohio was transported in Pre-Wisconsinan drainage systems (Pavey et al. 1999)

Collectively, the entire sequence of glacial deposits is called glacial drift regardless of age or sediment type (Angle 2004). This glacial drift is of utmost importance to Ohio and its economy since the drift is a valuable natural resource. For example, a soil profile has developed on the surface of the till, allowing it to be used in agriculture (USDA 1973). The till also serves as a natural filter for water as the water percolates down into an aquifer. The till also creates an excellent substrate for buildings.

Study Area and Background

Location

The study area for this project is located in south-central Fayette County, Ohio. Fayette County is located approximately 50 miles southwest of Columbus and approximately 70 miles northeast of Cincinnati. Washington Court House has the largest population and serves as the centralized county seat. The land use includes private homes, farming, and several manufacturing industries (Angle 2004).

Previous Work

The geology of Fayette County includes an irregular bedrock surface, composed of Silurian dolomites for most of the county, but with a thin Devonian cap of Ohio and Olentangy shales to the east (Bownocker 1920). Overlying the bedrock are glacial deposits of varying types and ages, probably from two or more continental glaciations that affected the region (Stout et al 1943). Only deposits of the Wisconsinan glacial stage are well preserved in the county's current topography of hills and plains (Pavey et al. 1999).

Surface Topography

Across the county, the Wisconsinan deposits are relatively unnoticed by the local people as they live, walk, and drive on them everyday. These deposits are unnoticed because the changes in elevation occur over a considerable distance, giving the false impression that the county is relatively flat, except for modern drainage ditches and streams. However, four named hummocky end moraines of the Wisconsinan Scioto Lobe cross the county (Hansen 1997). In addition, areas of small unnamed kames can be identified near the community of Buena Vista and to the east of Washington Court House

(Angle 2004). The end moraines are the Bloomingburg, Esboro, Glendon, and Reesville moraines (Quinn and Goldthwait 1985). These moraines trend approximately northwest to southeast, curving toward the southwest, which indicates that the glacier's terminus was facing to the southwest as the end moraines were formed (Pavey et al. 1999).

Current Research

Study Area Background

This study focuses on the glacial deposits found in the subsurface of south central Fayette County. A profile was constructed along Miami Trace Road as shown in Figure 4. Previous work done by the Division of Geological Survey, ODNR, has shown that the paleotopography beneath this profile is highly variable. In addition, the composition of the bedrock also changes. Apparently in response to this paleotopography, there is a noticeable thickening and thinning of the glacial drift as shown in Figure 5.

Bedrock Lithologies

The resistance of the bedrock in Fayette County, mainly Silurian dolomites and Devonian shales, to glacial erosion and erosion by the pre-glacial Teays River, changes across the county (Stout et al. 1943). In western Green Township, the oldest bedrock encountered is Greenfield Dolomite, which is overlain by the younger Tymochtee Dolomite. Overlying the Tymochtee Dolomite is the younger undifferentiated Salina Group made up of dolomite and minor anhydrite and gypsum deposits. In the vicinity of Rock Mills, a short section of the Tymochtee Dolomite is exposed where Paint Creek has downcut into the bedrock. At the easternmost end of the line of study, the Devonian shales are present. The Ohio and Olentangy Shales (undivided) form the top of bedrock highs (Bowknocker 1920).

Teays Stage and Deep Stage Drainages

This area's pre-glacial drainage was modified by Pleistocene glacial activity. The exposed bedrock surface was eroded for millions of years prior to any glaciation. This erosion created some the bedrock topography found in the subsurface today, as streams eroded wide channels. The oldest episode of drainage development is known as the Teays Stage because these small tributaries fed the Teays River, which crossed Ohio from south-southeast to the northwest (Hansen 2003). Stout et al. (1943) have reported the presence of a small Teays Stage tributary in the vicinity of Good Hope, which is adjacent to the study area (Fig. 1). In addition, Stout et al. (1943) have mapped a younger, Deep Stage drainage channel in the middle of the study area, along the boundary between Perry Township and Wayne Township (Fig. 2). It appears that this drainage channel lies in the same position as the modern day Paint Creek, which crosses Miami Trace Road at Rock Mills. Sufficient data to address the possibility that the drainage of this area was modified during the Illinoian ice advance is lacking in the literature, and can only be identified tentatively from the use of well logs. In the case of Paint Creek, the second to last advance likely helped to erode the existing channel of the Deep Stage further (Stout et al. 1943). Following retreat of the Wisconsinan ice, the area's current drainage was developed around the elevated Glendon Moraine and Esboro Moraine into the lower ground moraine and pre-existing streams such as Paint Creek (Fig. 3).

Glacial Deposits

The glacial deposits lie above the weathered bedrock surface. The study area includes at least one end moraine, the Glendon Moraine, and areas of intervening ground moraine. The present-day Miami Trace Road near its intersection with Stafford Road lies upon the crest of the Glendon Moraine. This moraine is easily identified from observation and by use of topographic maps because it generally lies to the east of Rattlesnake Creek. Proceeding east along Miami Trace Road, ground moraine is soon encountered shortly after crossing Cross Road. The gradual transition occurs roughly halfway between Cross Road and Washington-New Martinsburg Road. The elevation increases again east of leaving Rock Mills, suggesting either the presence of a second end moraine or the effect of a high in the bedrock paleotopography. However, post-Pleistocene erosion has made correlating this remnant piece to a larger end moraine. This feature, if it is the easternmost end moraine in the study area, could be associated with the deposition of the Esboro Moraine (Pavey et al. 1999).

Surface Weathering and Erosion

For approximately the last 15,000 years (Quinn and Goldthwait 1985), the surface of the Wisconsinan glacial deposits has been exposed to weathering and plant growth. The result is a soil profile that is fertile enough to grow crops. In this time, however, there has been modification of the topography (Plummer et al 2003). The outcome is a surface where it is even sometimes difficult to distinguish glacial landforms from those caused by erosion.

Data Sources and Methods

Water well logs and drilling reports for this area were the main source of data, and were obtained from the Ohio Department of Natural Resources (ODNR), Division of Water. A recent report on groundwater pollution potential published by the Division of Water (Angle 2004) also served as a local reference on the glacial deposits. Topographic maps served to define glacial features and present-day drainage. Local bedrock topography maps were examined to confirm the accuracy of the cross section. Several open file bedrock reconnaissance maps and open file bedrock topography maps were used to define the composition of the bedrock and the topography of its upper surface. The study primarily focused on the New Martinsburg Quadrangle because it contained the stretch of Miami Trace Road used for the cross section. The Division of Geological Survey, ODNR, supplied the previously mentioned maps, a state glacial map, and general information about Ohio's glacial history. Stout et. al (1943) provided the data about interpretations of drainage changes caused by the glaciations.

Thirty-two well logs were compiled, and the elevations of the tops and bottoms of distinct lithologic intervals in each well were entered into a spreadsheet (ODNR, Division of Water). One difficulty with using the water well log data arose because a uniform terminology had not been applied by all the drilling contractors for similar deposits. This difficulty was resolved by comparing descriptions between adjacent wells and by applying personal experience from the area, which resulted in subdivisions of "clay" (oxidized till), "sand", and "hardpan" (unoxidized till) for the purpose of constructing the cross-section. The latter lithology, "hardpan", requires some clarification as it is used differently this study than in soil descriptions. As strictly defined, "hardpan" would refer to an interval of precipitated calcite in a soil (Plummer et al. 2003). When used in Fayette County, Angle (2004) states that the term "hardpan" is used as the name for a "boulder clay", which is closer to the classification used by the drillers. Drillers classify an interval as being "hardpan" mainly by the presence of a brown streak or "oil slick" on top of the slurry coming from the well. Generally, "hardpan" then describes unoxidized till that varies from being mostly blue-gray to brown, and consists of gravel, sand, silt, and clay.

The original well log data as recorded on well logs and drilling reports is presented in Appendix as Table 1. The data in Table 1 was reinterpreted in order to standardize lithologic names. This divided the glacial deposits into three different lithologies (unoxidized clay loam, sand, and hardpan), which were mapped in a cross-section and interpreted for the main sequence of events during the Wisconsinan. The reinterpreted well log lithologies, used in the cross section, are presented in the Appendix as Table 2. A topographic map of the New Martinsburg Quadrangle, showing the location of the cross section, is included as Figure 4. The cross section with an explanation is included as Figure 5.

Results

The glacial drift is thickest on western and eastern ends of the cross-section (Fig. 5), with a maximum thickness of approximately 50 feet. In general the drift is thinnest in the east-central part of the cross-section where it has been completely eroded away in some places. To some extent, this thinning of the glacial drift occurs as the bedrock surface rises. The primary exception to this relationship is at the bedrock low in Paint Creek, where post-glacial erosion has removed the glacial drift. Within the glacial drift, there were two sequences of sediments that occurred downward from the surface. In the bedrock lows, a sequence of clay, sand, and hardpan had been deposited. On bedrock highs, the primary deposit was oxidized clay.

Along the mostly east-west profile of Fig. 5, there are noticeable changes in both bedrock elevation and surface elevation. The bedrock topography appears to have been influenced by both the Teays Stage and the Deep Stage drainages. For example, areas in the bedrock with gentle slopes and topographic relief of 20 feet to 30 feet over a horizontal distance of approximately 2500 feet may be former drainage channels of the Teays Stage. More evident is the channel of present-day Paint Creek, approximately 60 feet deep and narrow; most likely this channel was developed during the Deep Stage. The combined effects of the Teays Stage and the Deep Stage drainages created the highly irregular contact between the bedrock and the glacial drift.

Within the upward glacial drift sequence of hardpan overlain by sand overlain by clay, there seems to be a pattern in lateral changes in thickness. Hardpan is found in bedrock lows where the paleotopography allowed for its deposition and preservation. Overlying the hardpan, the sand is present in wells located above bedrock lows and absent in wells located above bedrock highs. The sand is thin averaging approximately a 2 feet thickness across this area.

On the surface, topography is uneven crossing the Glendon Moraine, ground moraine, and a high surface topography east of Rock Mills. The current drainage was shaped by these glacial features; typically occurring along the edge of an end moraine (Fig. 3). In addition, the surface has been further modified by the effects caused by post-glacial erosion and land development.

Discussion

The bedrock paleotopography and glacial stratigraphy of south-central Fayette County appears to carry records of two pre-glacial drainage patterns, as well as the record of at least the most recent ice advance and retreat. In addition, details within the glacial stratigraphy vary across the study area, suggesting that the underlying bedrock paleotopography affected glacial processes and deposition during the Wisconsinan.

The bedrock surface in much of the western portion of the cross-section is relatively shallow and with low relief. Based on previous work by Stout et. al (1943), this topography resembles a pre-glacial erosional surface produced during the Teays Stage. However, this interpretation has not been directly tested. The nearest proposed tributary of the Teays Stage drainage is a few miles south of the cross-section on the boundary between Perry and Wayne townships (Stout et al. 1943). A dendritic drainage pattern appears to be formed by the reconstructed Teays Stage channels, based on well data (Plummer et al. 2003). As a result, it appears likely that the feature near the west end of this cross-section represents a small channel that fed into the larger tributary to the south.

The only likely example of Deep Stage drainage, as cited by Stout et al. (1943), occurs at Rock Mills, where present day Paint Creek flows in a deeply carved valley incised approximately 60 feet into the Tymochtee Dolomite. Stout et. al (1943) show this drainage as connecting with the former Bourneville River, located to the south in Highland and Ross counties. The present-day Paint Creek is an excellent example of an underfit stream, suggesting that the channel of Paint Creek formed at a time of significant higher discharge in the past, such as during a time of meltwater input.

The presence of Illinoian glacial sediments in the surrounding counties (Clinton, Highland, and Ross counties) suggests that Illinoian ice moved through the study area (Pavey et al. 1999). However, no Illinoian or pre-Illinoian sediments are known from the study area, indicating that these older deposits were eroded and reworked by the Wisconsinan glacial advance. The effects of this reworking may also be indicated by the relatively thin section of glacial drift along the cross-section.

Events during the Wisconsinan can be interpreted in some detail based on the data from water well logs, which generally indicate an upward sequence of hardpan, discontinuous sand, and oxidized till preserved in lows on the bedrock surface with the exception of modern day Paint Creek where the glacial drift has been eroded away. One possibility is that the ice advanced steadily across the area, depositing a layer of till varying from 10 feet to 30 feet of preserved thickness in bedrock lows. This advance was followed by an episode of basal warming, as recorded in the interval of sand and (in some cases) gravel encountered in most wells in the study area. This interprets the sand and gravel as a winnowed interval, derived from the underlying till, formed as increased amounts of subglacial meltwater removed the silts and clays. Because the sand tends to occur in areas where the bedrock surface is low, it appears that a remnant shape of the former bedrock topography was reflected in the overlying sediments that caused some of the meltwater flow to be concentrated above bedrock channels. Generally, the sand is about two feet thick which is impressive when considering the amount of meltwater needed to sort it out of till with approximate sand and gravel content of 35% to 40% (Quinn and Goldthwait 1985). If the original till had this percentage of sand and gravel, then the sand layer of 2 feet thickness has been produced by winnowing 5 feet to 6 feet of till. The upper till layer is interpreted to have been deposited englacially or supraglacially from the melting of debris-rich ice. Following this last depositional event, the younger till was oxidized to a "clay loam" while the lower till compacted into "hardpan". Another possibility is that the sand and gravel overlying parts of the older till represent a brief retreat of the ice that caused winnowing by proglacial meltwater that again followed remnants of lows in the bedrock. The upper till would then record a subsequent readvance (perhaps eroding what became the "hardpan" from the bedrock highs) and retreat.

The present day topography reflects the positions of the retreating glacier. Retreat of the Wisconsinan ice was episodic, with a temporary stationary position (Plummer et al.2003) recorded by the recessional Glendon Moraine. This feature is a hummocky moraine well-defined by a line of rolling hills, most likely made of sediments either from the debris-rich surface of the glacier or from englacial sediment, because this material does not appear to have been compacted by the weight of the overriding ice (Benn and Evans 1998). In the till that dominates these end moraines, small lenses of sand and gravel record episodes of increased meltwater flow during deposition (Angle 2004, see Figure 6). The presence of a small kame field nearby, at Buena Vista, supports the interpretation that this sediment was supplied from the debris-rich surface of the glacier (Benn and Evans 1998). Following the pause in retreat when the Glendon Moraine was formed, the ice retreated a short distance while depositing the thin blanket of till that forms the ground moraine between the Glendon and Esboro Moraines (Plummer et al. 2003). This area (shown in Fig. 3) is covered by ground moraine, but is described as a "till plain" because of its almost flat topography (Brockman 1998). The middle portion of the cross-section (Fig. 5) crosses this region of ground moraine and illustrates the resulting surface topography. A younger pause in glacial retreat is recorded by the Esboro Moraine, which may be crossed by the easternmost part of the cross-section. However, much of the Esboro Moraine in the area has been eroded away, so its position is difficult to trace.

The last step in the sequence of glacier-related influences involves the reworking of the sediments and surface topography through glaciofluvial processes, weathering, and erosion (Plummer et al. 2003). Meltwater helped to establish the current drainage pattern, with end moraines being drainage "divides" and the ground moraines being favorable to streambed development (Angle 2004). In addition, the meltwater sorted sand and gravel into the streambeds, while washing the fines downstream (Stout et al. 1943).

Erosion and weathering subsequently played a major role in modifying these sediments. First, surface runoff eroded away some of the sediments, especially on the steeper end moraines. A major modification involved the interaction with oxidizing pore waters, transforming the till into yellow-brown "clay loam". Regardless of whether the landform is an end moraine or ground moraine, the till has been oxidized to a depth of approximately fifteen feet. The slight changes in oxidization can be caused by presence of fractures in the till increasing permeability, and amount of time water was able to stay in contact with the till. In places, significant organic matter has been added to the altered till to form topsoil. This uppermost layer of topsoil usually is black and is highly desirable for plant grow (Plummer et al. 2003).

Summary and Conclusions

The subsurface profile along Miami Trace Road shows a relationship between the bedrock topography and the thickness of glacial deposits, and provides information that can be used to interpret the history of deposition of those sediments. The drift is thinner in areas of ground moraine, in areas subject to significant post-glacial erosion, and on bedrock highs. The bedrock lows most likely represent streams that existed during the Teays Stage or the Deep Stage depending on their shapes and orientations. Unfortunately, a detailed glacial history can only be constructed for the Wisconsinan, based on the existing glacial deposits - - a thin to medium drift coverage of clay loam, sand, and hardpan, which is most complete in lows on the bedrock surface. As previously discussed, this sequence of oxidized clay loam, sand, and hardpan appears to record a sequence of five events: initial advance and till deposition, an episode of increased meltwater influence (either proglacial or subglacial), a second episode of till deposition, glacial retreat with occasional stillstands to form the end moraines, and weathering/erosion that helped to create the present-day surface.

Other interpretations of this sequence are possible, but would require additional data and age control for support. For example, a compositional analysis could help to determine if the source of the sediments was the same throughout this sequence. Compositional similarity would support the interpretation that all these sediments are Wisconsinan, whereas a significant compositional change within the sequence might indicate a more complex depositional history. Even better, a systematic age analysis using all appropriate methods could help define the retreat history of the terminus of the glacier. In addition, a detailed study of the surficial glacial deposits is not available for the entire county, but would be very useful for understanding the sequence of Wisconsinan events. Integrating the glacial sediment data and the bedrock topography into a GIS based subsurface model for Fayette County and the surrounding counties would be very useful for mapping and understanding the Teays Stage and Deep Stage drainages better.

References

Angle, Michael P. "Ground Water Pollution Potential of Fayette County, Ohio." ODNR, Division of Water, Water Resources Section,Ground Water Pollution Potential Report No. 64 with Map. (2004) pp. 1-48.

Benn, Douglas I. and Evans, David J.A. "Glaciers and Glaciation." London: Arnold Publishers. (1998) pp. 1-734.

Bownocker, J.A., "Geologic Map of Ohio." ODNR, Division of Geological Survey. 1920.

Hansen, Michael C. "Ice Age Ohio." ODNR, Division of Geological Survey, Educational Leaflet No. 7 (Modified). (1997), pp.1-5.

----------------------. "The Teays River." ODNR, Division of Geological Survey, Geofacts No. 10. (2003), pp.1-3.

Ohio Dept. of Natural Resources, Division of Water. Well log and drilling reports (paper version) for Miami Trace Rd and surrounding area of Fayette County. Also available online: http://www.dnr.state.oh.us/water/maptechs/wellogs/app/default.asp

Pavey et al. "Quaternary Geology of Ohio Map No.2, with Text." ODNR, Division of Geological Survey. (1999)

Plummer et al. "Physical Geology." Ninth edition. Boston: McGraw-Hill. (2003) pp.283-309.

Quinn Michael J. and Goldthwait, Richard P. "Glacial Geology of Ross County, Ohio." State of Ohio Dept. of Natural Resources, Division of Geologic Survey, Report of Investigations No. 127. (1985) pp.1-42.

Rosengreen, Theodore Ernest. "The Glacial Geology of Highland County, Ohio." Dissertation. The Ohio State University. (1971) pp. 1-163.

Schumacher, Gregory A. "Preliminary Bedrock Geology for 7.5 Minute New Martinsburg Quadrangle."ODNR, Division of Geological Survey. (1994 Aug. 16)

Shrake L. Douglas. "Bedrock Topography for 7.5 Minute New Martinsburg Quadrangle." ODNR, Division of Geological Survey. (March 1993).

Revisions by Schumacher, Gregory A. (1994 Aug 12 and Nov. 9)

"Soil Survey, Fayette County, Ohio." United States Dept. of Agriculture et al. (December 1973) pp. 1-82.

Stout et al. "Geology of Water in Ohio (A Basic Report)." Geological Survey of Ohio Fourth Series Bulletin 44. (1943), pp. 117-125, 289-292.

Teller, James Tobias. "The Glacial Geology of Clinton County, Ohio." M.S. Thesis. The Ohio State University. (1964) pp.1-106.

United States Geological Survey. Topographic map for 7.5 minute New Martinsburg Quadrangle. (1960)

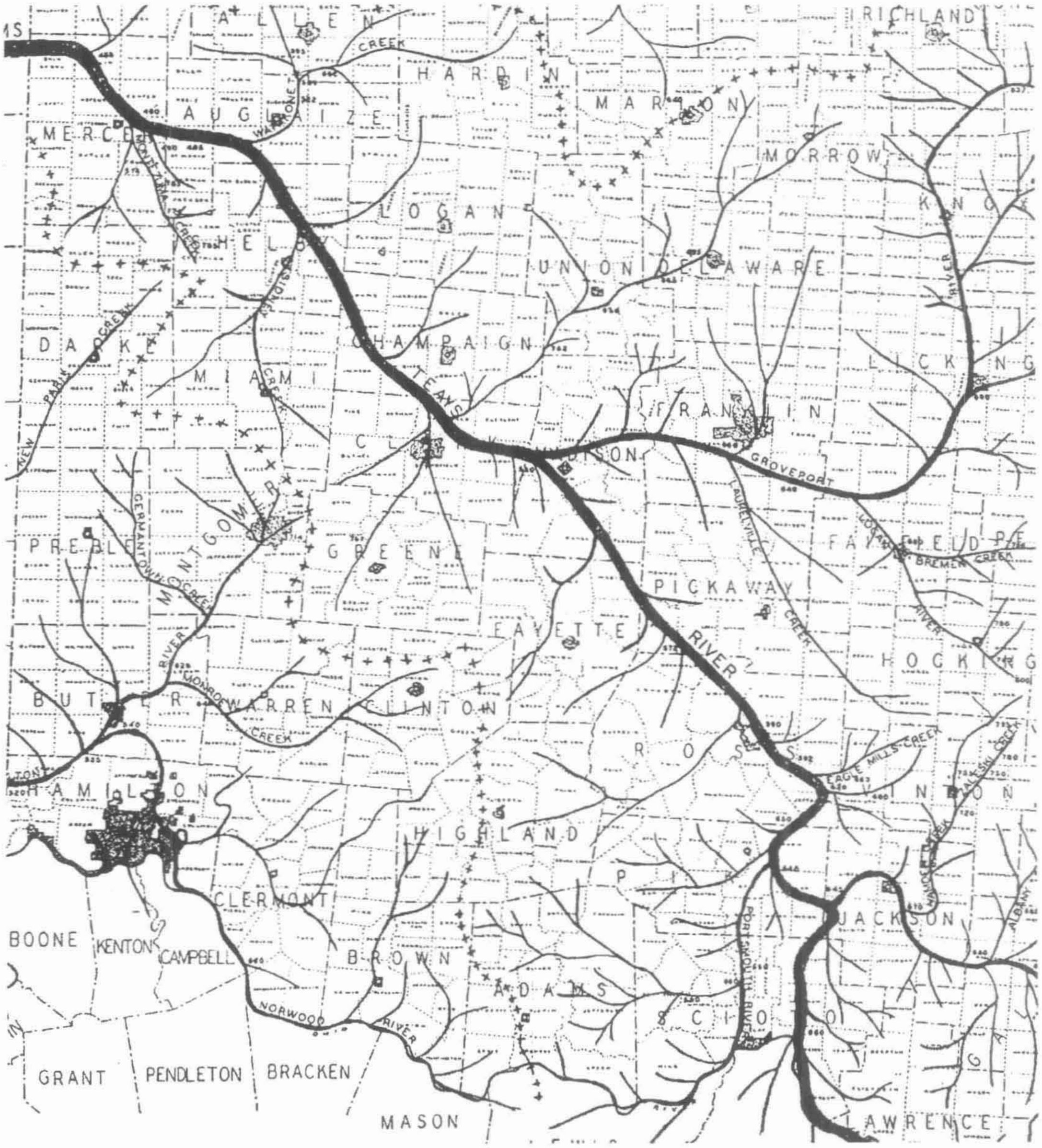


Figure 1

Teays Stage Drainage (after Stout et al., 1943)

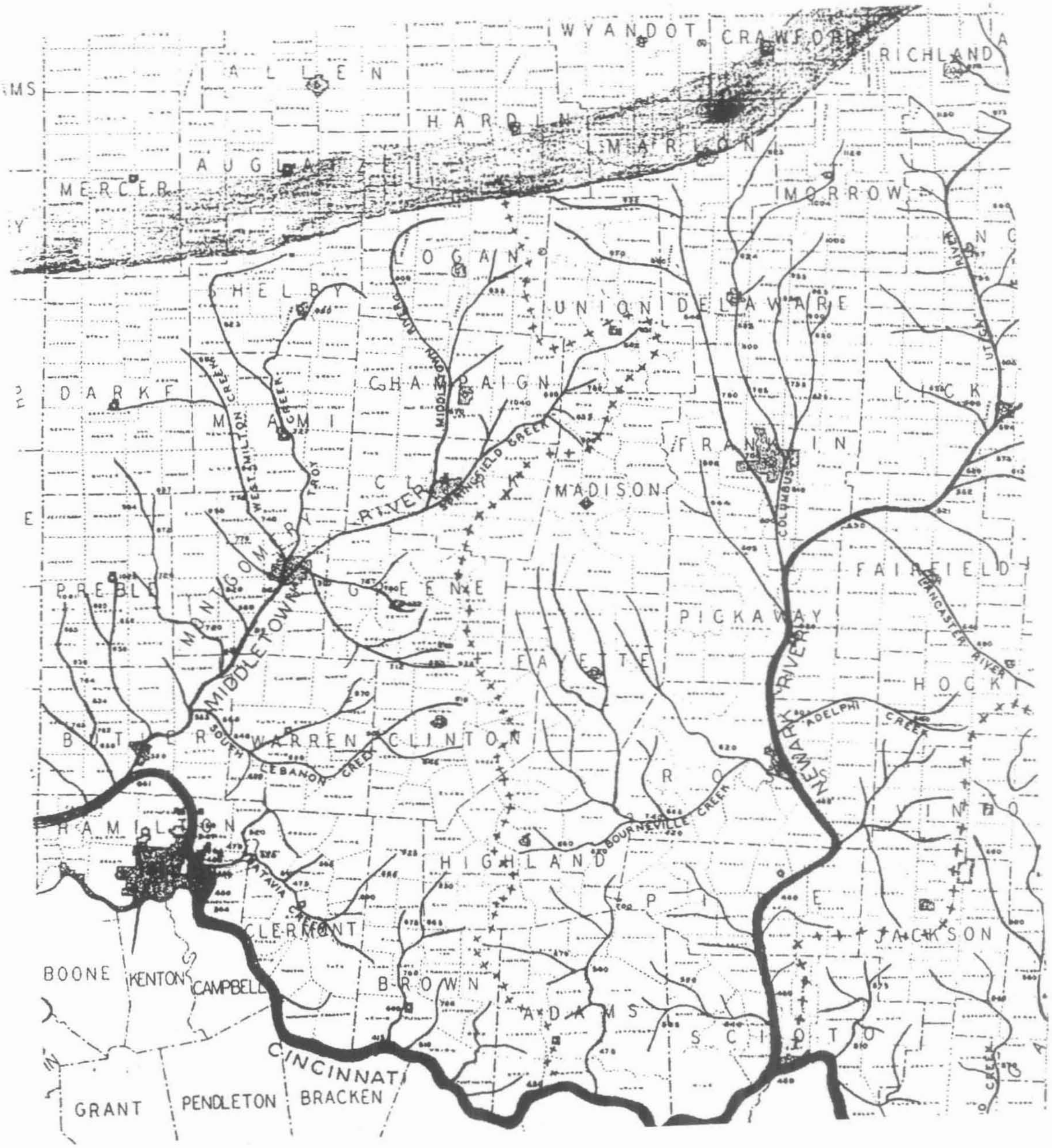
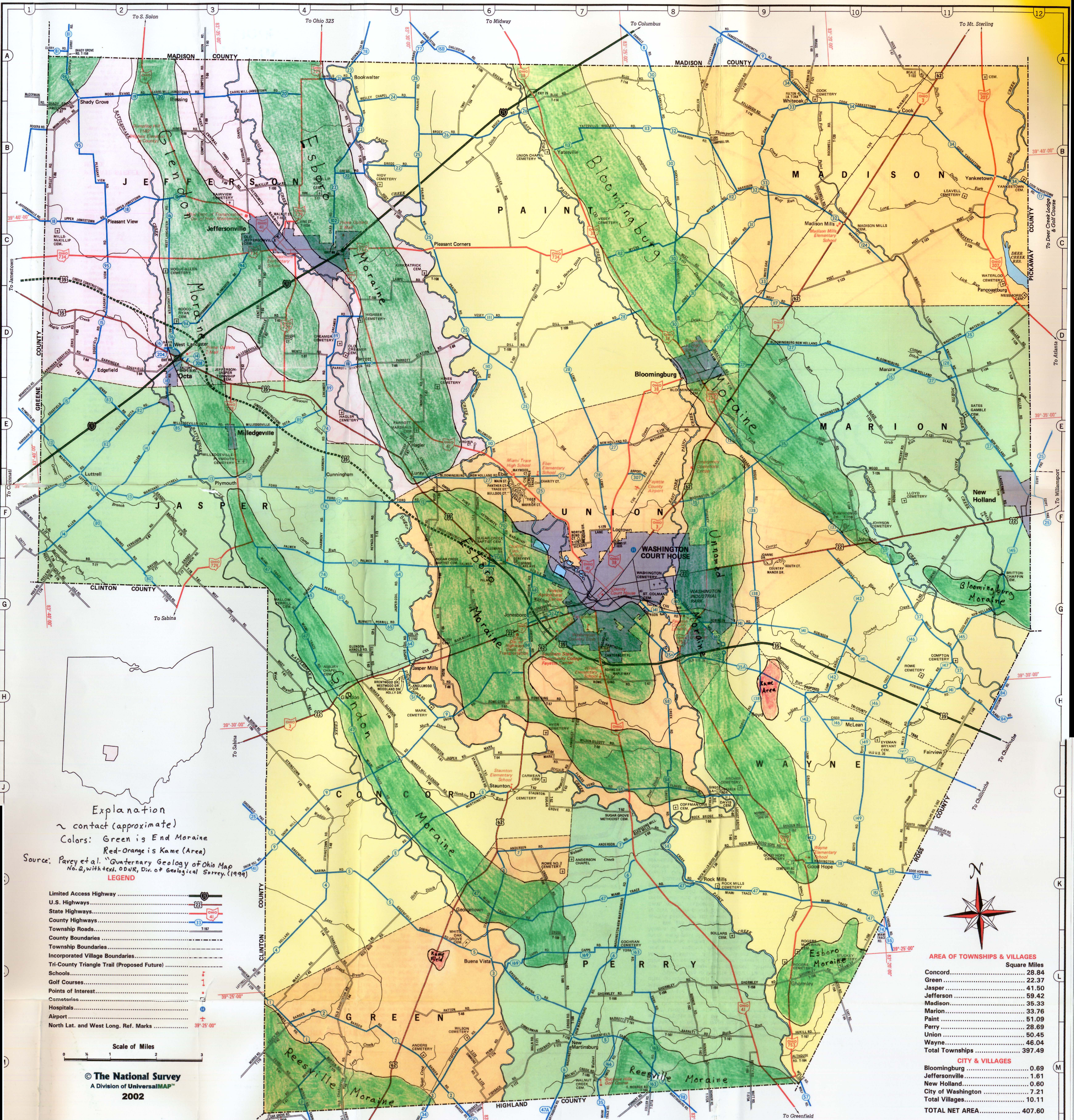


Figure 2

Deep Stage Drainage (after Stout et al. 1943)



FAYETTE COUNTY OHIO

…even G. Luebbe, P.E.,P.S.
County Engineer
2002

FOR FREE DISTRIBUTION ONLY

TOWNS/VILLAGES **COUNTY ROADS** **TOWNSHIP ROADS**

USEFUL INFORMATION

PHONE NUMBERS
(Area Code 740)

City Building	636-2340
Commissioners	335-0720
Engineer	335-1541
Map Office	335-2334
ODOT	335-1800
Police	636-2370
Sheriff	335-6170

FAX NUMBER

Engineer	333-3573

ZIP CODES

Bloomingburg	43106
Good Hope	43121
Greenfield	45123
Jamestown	45335
Jeffersonville	43128
Leesburg	45135
Milledgeville	43142
Mount Sterling	43143
New Holland	43145
Sabina	45169
South Solon	43153
Washington C.H.	43160

2002 Highway Map of FAYETTE COUNTY OHIO

Fayette County Area 407.6 Sq. Miles
POPULATIONS (2000 CENSUS)
Fayette County 28,433

TOWNSHIPS

	Population
Concord	1,068
Green	499
Jasper	857
Jefferson	2,766
Madison	946
Marion	748
Paint	1,905
Perry	945
Union	3,808
Wayne	1,367
City of Washington	13,542

Township Roads	208.08 Miles
County Highways	305.64 Miles
State Highways	85.00 Miles
U.S. Highways	71.31 Miles
Interstate Highways	14.65 Miles
Total of all Roads	684.68 Miles

Board of Commissioners
BOB PETERSON
JACK DEWEESE
JOHN SCHLICHTER

FOR FREE DISTRIBUTION ONLY

Figure 3

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

NEW MARTINSBURG QUADRANGLE
OHIO
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 GREENFIELD 15' QUADRANGLE

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1959. Field check 1960

Polyconic projection. 1927 North American datum
10,000-foot grid based on Ohio coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks,
zone 17, shown in blue

Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked

Entire area lies within the Virginia Military District

APPROXIMATE MEAN DECLINATION, 1960

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Explanation

⊙ Approximate well location

A—A' Segment of Profile Line

NOTE: Small number corresponds to Well data in Appendix

ROAD CLASSIFICATION

Heavy-duty — Light-duty

Medium-duty — Unimproved dirt

U. S. Route — State Route

QUADRANGLE LOCATION

NEW MARTINSBURG, OHIO
NW/4 GREENFIELD 15' QUADRANGLE
N3922.5—W8322.5/7.5

1960

Profile Line Map

Figure 4

Bedrock Topography and Glacial Stratigraphy
of South-Central Fayette County, Ohio
By: Harold E. Johnson II
August 26, 2005
Vertical Exaggeration 20X

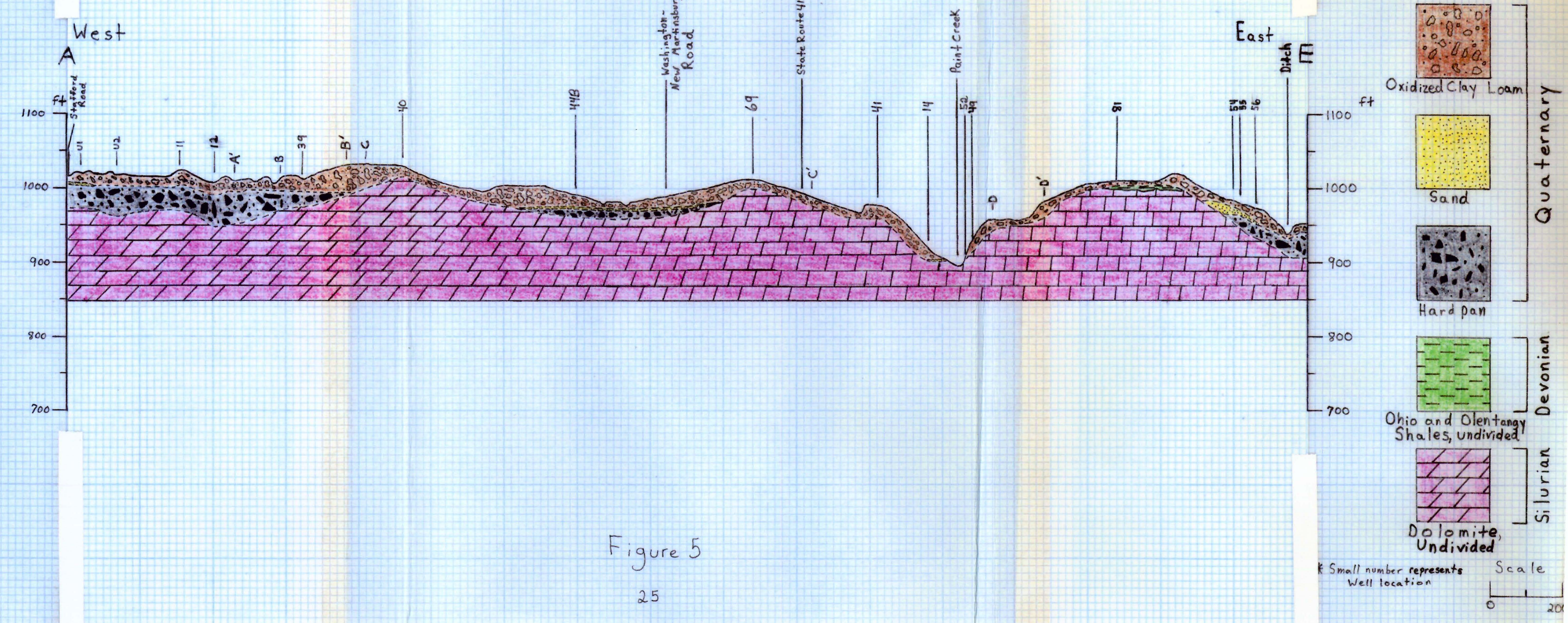


Figure 5

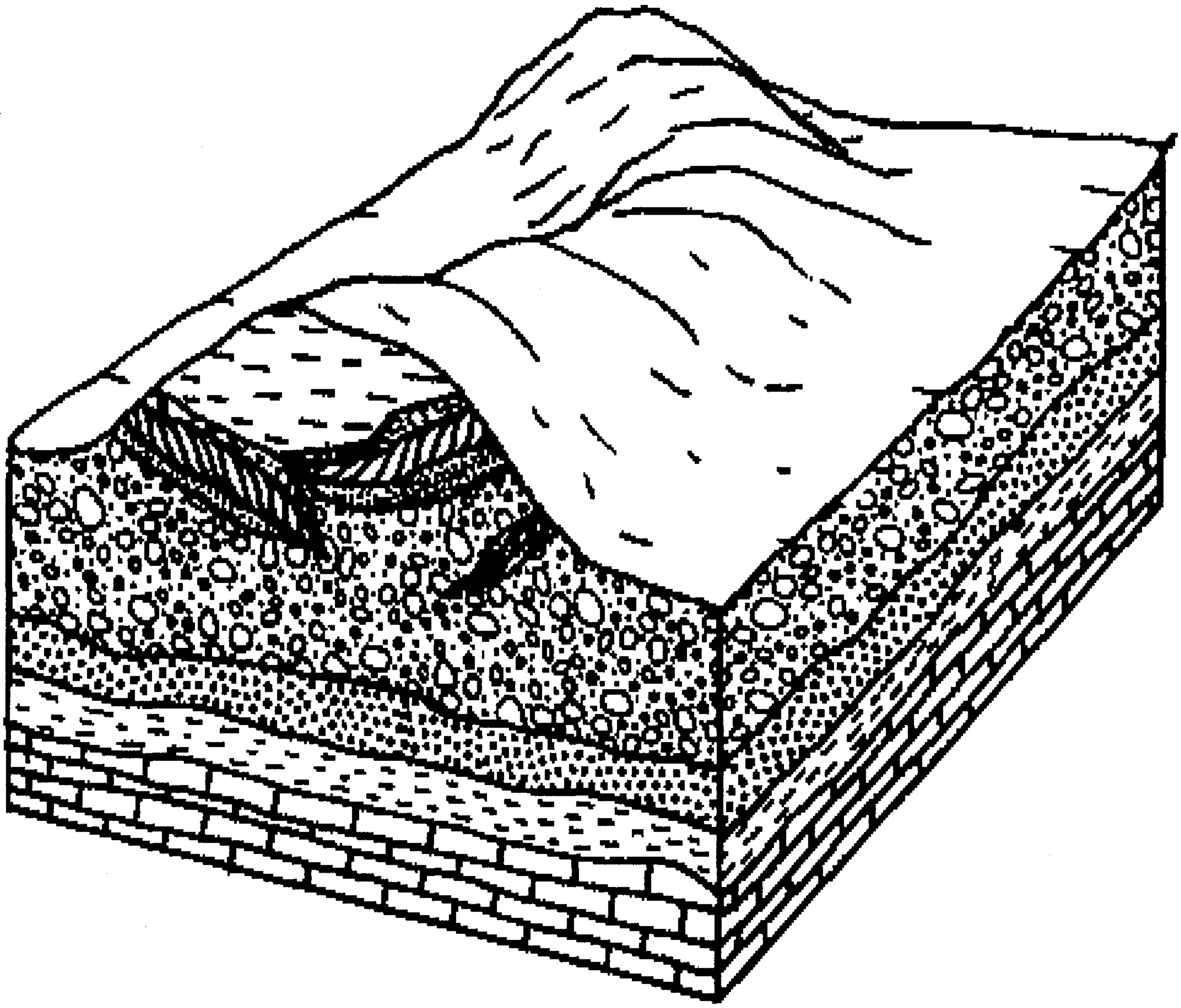


Figure 6

End Moraine Structure (after Angle 2004)

Appendix

Table 1
Original Drillers' Glacial Drift Data of Selected Well Logs*

Well Location Number	Old/Dug Well From (ft)	Old/Dug Well To (ft)	Top Soil From (ft)	Top Soil To (ft)	Carbonate Rock (Limestone) From (ft)	Carbonate Rock (Limestone) To (ft)	Clay From (ft)	Clay To (ft)	Mudsand From(ft)	Mudsand To(ft)
11							0	52		
12							0	15		
13							0	6		
14							0	18		
39			0	1			1 (yellow w/grit)	15 (yellow w/grit)		
40			0	2			2 (w/gvl+grit)	15.5 (w/gvl+grit)		
41							0	17		
42	0	20								
43***	0	11								
43a***							0	13		
43b***							0 (w/gvl)	26 (w/gvl)		
43c***										
44***							0	18		
44a***										
44b***							0	12		
48***	0	22								
48a***							0	4		
49							0	12		
50							0	15		
51							0	18		
52			0	2	2	6				
53							0	14		
54							0	10		
55							0	10		
56							0	26		
68	0	109								
69							0	9		
81							0	6		
85							0	12		
U1**							0	10		
U2**							0	32		
U3**							0	17		

*Data recorded at earth's surface with depth increasing to the right
** U denotes wells not located by ODNR, Division of Water
*** Lower case letter designates multiple wells at location; collective and representive data at these locations

Table 1
Original Drillers' Glacial Drift Data of Selected Well Logs*

Well Location	Sand	Sand	Gravel	Gravel	Clay	Clay	Hard Pan	Hard Pan	Mudsand	Mudsand	Hard Pan	Hard Pan	Mudseam?	Mudseam?
Number	From (ft)	To (ft)	From (ft)	To (ft)	From(ft)	To(ft)	From (ft)	To (ft)	From (ft)	To (ft)	From (ft)	To (ft)	From (ft)	To (ft)
11	52	53												
12							15	45	45	50	50	59		
13							6	34						
14	18	19												
39					15 (blue w/grit)	25 (blue w/grit)								
40														
41														
42							20	50						
43**														
43a**	13	16					16	37						
43b**			26	29	29	30.5								
43c**														
44**	18 (w/gvl)	20 (w/gvl)			20	23								
44a**														
44b**			12 (w/clay)	15 (w/clay)			15	25						
48**														
48a**							4	20					20	25
49														
50	15	17												
51														
52	6 (w/gvl)	10 (w/gvl)												
53							14	20						
54	10	20					20	30						
55	10	18					18	30	30	38				
56	26	27					27	38						
68														
69														
81														
85	12	15												
U1*	10	10.5			10.5	30								
U2*	32	34			34	52								
U3*														

*Data recorded at earth's surface with depth increasing to the right

** U denotes wells not located by ODNR, Division of Water

*** Lower case letter designates multiple wells at location; collective and representive data at these locations

Table 1
Original Drillers' Glacial Drift Data of Selected Well Logs*

Well Location Number	Sand and Gravel From (ft)	Sand and Gravel To (ft)	Clay From (ft)	Clay To (ft)	Sand and Gravel From (ft)	Sand and Gravel To (ft)	Depth to Bedrock (ft)	Drilling Firm/ Driller	Drilling Method
11							53	McCoy Well Drilling	Cable Tool
12							59	Staunton Well Drilling	Cable Tool
13							34	R.H. Trefz	Cable Tool
14							19	Shorts Well Drilling	Cable Tool
39			25 (yellow w/grit)	36 (yellow w/grit)			36	Skinner Bros.	Cable Tool
40							15.5	Skinner Bros.	Cable Tool
41							17	Leo E. Thompson	Cable Tool
42							50	R.H. Trefz	Cable Tool
43**							11	McCoy Well Drilling	Cable Tool
43a**							37	McCoy Well Drilling	Cable Tool
43b**							30.5	McCoy Well Drilling	Cable Tool
43c**							71?	McCoy Well Drilling	Cable Tool
44**							23	McCoy Well Drilling	Cable Tool
44a**							grd surface?	R.H. Trefz	Cable Tool
44b**	25	27.5					n/a	McCoy Well Drilling	Cable Tool
48**							22	R.H. Trefz	Cable Tool
48a**							25	R.H. Trefz	Cable Tool
49							12	McCoy Well Drilling	Cable Tool
50							17	Staunton Well Drilling	Cable Tool
51							18	Ezra H. McCarty	Cable Tool
52							10	Shorts Well Drilling	Cable Tool
53							20	R.H. Trefz	Cable Tool
54	30 (gravel)	32.5 (gravel)					32.5	Shorts Well Drilling	Cable Tool
55							38	Shorts Well Drilling	Cable Tool
56	38 (sand)	40 (sand)					40	Shorts Well Drilling	Cable Tool
68							109?	McCoy Well Drilling	Cable Tool
69							9	Staunton Well Drilling	Cable Tool
81							6	Ohio Rotary Drilling	Rotary
85							15	Staunton Well Drilling	Cable Tool
U1*	30 (sand)	34 (sand)	34	42	42	46	46	Charles Campbell	Cable Tool
U2*	52 (sand)	53 (sand)	53	55			55	Rearick Drilling	Cable Tool
U3*							17	H.E. Johnson Well Drilling	Cable Tool

*Data recorded at earth's surface with depth increasing to the right
** U denotes wells not located by ODNR, Division of Water
*** Lower case letter designates multiple wells at location; collective and representive data at these locations

Table 2
Reinterpreted Glacial Drift Data of Selected Well Logs*
(Highlighted Selections used to construct cross section)

Well Location Number	Clay From (ft)	Clay To (ft)	Sand From (ft)	Sand To (ft)	Hard Pan From (ft)	Hard Pan To (ft)	Depth to Bedrock (ft)	Drilling Firm/ Driller	Drilling Method
11	0	Omitted	Omitted	Omitted	Omitted	Omitted	53	McCoy Well Drilling	Cable Tool
12	0	15			15	59	59	Staunton Well Drilling	Cable Tool
13	0	6			6	34	34	R.H. Trefz	Cable Tool
14	0	18	18	19			19	Shorts Well Drilling	Cable Tool
39	0	15			15	36	36	Skinner Bros.	Cable Tool
40	0	15.5					15.5	Skinner Bros.	Cable Tool
41	0	17					17	Leo E. Thompson	Cable Tool
42	0	20			20	50	50	R.H. Trefz	Cable Tool
43***	0	11					11	McCoy Well Drilling	Cable Tool
43a***	0	13	13	16	16	37	37	McCoy Well Drilling	Cable Tool
43b***	0	26	26	29	29	30.5	30.5	McCoy Well Drilling	Cable Tool
44***	0	18	18	20	20	23	23	McCoy Well Drilling	Cable Tool
44b***	0	12	12	15	15	27	27	McCoy Well Drilling	Cable Tool
48***	0	4			4	22	22	R.H. Trefz	Cable Tool
48a***	0	4			4	20	25	R.H. Trefz	Cable Tool
49	0	12					12	McCoy Well Drilling	Cable Tool
50	0	15	15	17			17	Staunton Well Drilling	Cable Tool
51	0	18					18	Ezra H. McCarty	Cable Tool
52	0	6	6	10			10	Shorts Well Drilling	Cable Tool
53	0	14			14	20	20	R.H. Trefz	Cable Tool
54	0	10	10	20	20	32.5	32.5	Shorts Well Drilling	Cable Tool
55	0	10	10	18	18	38	38	Shorts Well Drilling	Cable Tool
56	0	26	26	27	27	40	40	Shorts Well Drilling	Cable Tool
69	0	9					9	Staunton Well Drilling	Cable Tool
81	0	6					6	Ohio Rotary Drilling	Rotary
85	0	12	12	15			15	Staunton Well Drilling	Cable Tool
86	0	14					14	Staunton Well Drilling	Cable Tool
U1**	0	10	10	10.5	10.5	46	46	Charles Campbell	Cable Tool
U2**	0	32	32	34	34	55	55	Rearick Drilling	Cable Tool
U3**	0	17					17	H.E. Johnson Well Drilling	Cable Tool

*Data recorded at earth's surface with depth increasing to the right
** U denotes wells not located by ODNR, Division of Water
*** Lower case letter designates multiple wells at location; collective and representive data at these locations